Hungarian Truck Toll Mileage Index as a business cycle indicator

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Abstract

The National Toll Payment Services Plc. (NTPS Plc.) in Hungary is a state-owned economic organization whose basic task is toll collection (e-vignette, e-toll), provision of related services, and control of road use rights. Heavy goods vehicle with a total weight over 3.5 tons are required to pay an e-toll. The control system of NTPS Plc. operates 24 hours a day and 365 days a year. The toll control cameras installed on the toll road network recognize and record the data of vehicles passing through the intersection, which is important from the point of view of toll payment. The Hungarian Central Statistical Office receives the camera data of the NTPS Plc. in an anonymized form on monthly basis from 2019. The dataset contains the camera ID, GPS coordinates of cameras, recording time (year, month, day, minute, second), vehicle type code (e.g. car, truck, bus, etc.), the anonymized code of the license plate, as well as the vehicle's country code. Based on the database examined between January 2020 and March 2024, the data on trucks were selected for every month. The anonymized codes of license plates were sorted by time, and then the code of the camera making the next recording was assigned to a given record. Thus, at a given record level, the distance covered can already be determined based on the two cameras. Based on the GPS coordinates of the camera data, a distance matrix was created which contains the distance of each camera from the other cameras. This distance matrix can be used to calculate the distance travelled for every anonymized license plate of trucks.

These calculated distances for trucks were aggregated for every month and a monthly time series, namely Truck Toll Mileage Index (TTMI) was created with a basis of monthly average of 2020. Finally, this index was seasonally adjusted using JDemetra+ software. As a result, it can be stated that both the raw and the seasonally adjusted TTMI show a high correlation (0.8) with the corresponding fixed base index of industrial production. This research succeeded in forming a business cycle indicator with high explanatory power.

Keywords: business cycle indicator, truck toll mileage index, transport, industrial production

1. Introduction

Industrial production is an important indicator in Hungary, because the gross added value of industrial production accounts for one fifth of GDP. However, data on industrial production are only available for 35 days after the reference period. Our goal was to produce an indicator that shows a close relationship with industrial production, but is available much earlier than the reference period.

The main idea of this new Hungarian business cycle indicator is based on the German Truck Toll Mileage Index. Cox et al (2018) provides a detailed overview of the development of the German toll-based mileage index for trucks. In Germany, the distance-based toll was introduced at the beginning of 2005 for trucks with a total weight exceeding 12 tons, covering nearly 12,800 kilometers of federal highways. In the years that followed, the toll was extended, as a result of which in 2018 all trucks with a gross weight exceeding 7.5 tons were obliged to pay a toll on all federal highways. The toll to be paid is influenced by the distance travelled on toll road sections, the number of vehicle axles, the vehicle assembly and the emission classification. For truck toll invoicing, it must be registered in the toll system. In 2017, in 96% of all toll notifications, satellite signals determined the position of the truck, the distance travelled, and transmitted the data to the computer system of the toll operator using radio signals. Since 2008, the Federal Office for Goods Transport (Bundesamt für Güterverkehr) has published truck toll data monthly, on the 15th working day following the given month, and also annually in aggregated form according to various aspects.

The use of the data as a time series is influenced by the fact that the toll set for trucks has gradually increased over the years. To eliminate this, a 2015 average=100% fixed-base truck toll-based mileage index (Lkw-Maut-Fahrleistungsindex) was prepared, which takes the conditions at the time of introduction into account. In addition, of course, all mileage is also observed, but at the time of writing the study, a long enough time series was not yet available for this. The German Federal Statistical Office (Statistisches Bundesamt) calculated a correlation of 0.86 between the toll-based mileage index and the raw, non-seasonally adjusted index of manufacturing production. As monitoring the economic cycle is of paramount importance, in 2019 the German Federal Statistical Office began to publish the index in raw and seasonally adjusted form on a monthly basis, on the 10th day following the reference month, as an experimental statistic. (Destatis, 2023) Now, the index is published as part of official statistics.

Due to the coronavirus epidemic, on April 14, 2020, the daily publication of the data began on an experimental basis, 5-9 working days after the relevant day. The biggest challenge was the seasonal adjustment of the data, which was carried out by the German Federal Bank (Bundesbank). (Cox et al, 2020, p. 64)

Based on this German example, we tried to create a similar truck toll mileage index firstly on a monthly basis.

2. Hungarian Truck Toll Mileage Index

In this section, we provide an overview of the data source of the Hungarian Truck Toll-based Mileage Index (TTMI) and its calculation method. The Mileage Index, showing truck traffic, is already available on the 14th day following the given month using the toll payment camera data and is able to provide early indications of the industrial production of the previous period.

2.1 Data sources

The National Toll Payment Service Private Limited Company (NTPS Plc., NÚSZ Zrt. in Hungarian) is a state-owned business organization in Hungary whose main task is toll collection (e-sticker, e-toll) and related activities, as well as the control of road use rights. Trucks with a maximum permissible total weight of more than 3.5 tons are required to pay an e-toll.

NTPS Plc. operates its inspection system 24 hours a day and 365 days a year. The fixed toll control stations recognize and record the data of passing vehicles, which is important from the point of view of toll payment. The Hungarian Central Statistical Office (HCSO) takes over the fixed camera data of NTPS Plc. The data transfer covers the following indicators: the identifier of the fixed cameras, the recording time (year, month, day, minute, second), the type of vehicle (e.g. car, truck, bus, etc.), the license plate number of the recorded vehicle, and the nationality of the vehicle. The data is available from March 2019. Part of the data transfer is also the provision of the exact location of the cameras (with road section marking and GPS coordinates).

2.2 Method

Our calculation was complicated by the fact that the number of cameras changes from one month to the next, as they sometimes break down or new ones are installed. Since the number of cameras changes dynamically over time, in order to create a homogeneous time series, only the data of those cameras that were in operation during the entire examined period -with a maximum of 3 months' gap- are processed. The disadvantage of this method is that the raw data produced may change retroactively for the entire period if cameras are not monitored for a long time.

To generate the Mileage index of toll-subject trucks, the data of vehicles with a non-zero registration number, with two or more axles subject to toll, with a maximum permissible total weight of over 3.5 tons, are selected from the database. To produce the index, we have to create a data structure where camera observations are sorted by time and anonymized license plate. This structure is capable to measure the occurrence of a license plate by time and

camera position creating a route through the fixed checkpoints. Then, we created a distance matrix that uses each possible pair of the cameras, and created by querying the road distance from Google Maps API. Using this distance matrix, the length of the journey can be calculated for each given license plate number.

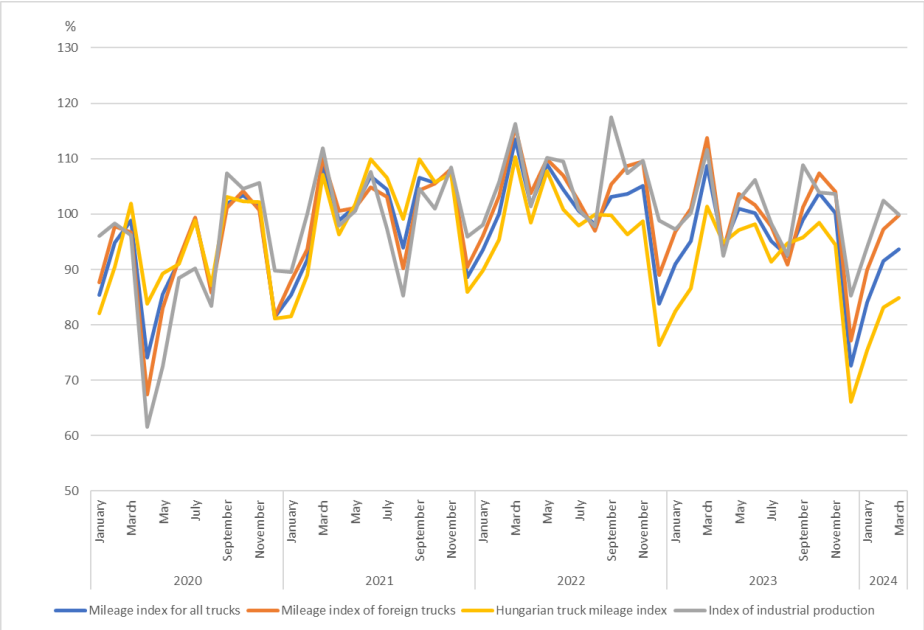
To handle possible camera errors, if for some reason a camera does not work on a given road section during a given period, we calculate the distance travelled from the camera that took the next recording in time. According to the method we use, the estimated distance can be missing only for those records where the truck covers a given road section between the last day of the month and the first day of the following month. At the same time, this error does not play a significant role in the estimated mileage. The introduction of the new Hungarian license plate numbers and the change in the vehicle registration system made the application of the method difficult and caused a break in the timeseries.

From the data calculated in this way and aggregated for a given month, we form a time series, calculating an index series of the year 2021 average=100% type for all trucks, as well as for trucks with foreign license plates and for Hungarian trucks, too. The index formed in this way is adjusted seasonally and with the effect of working days. The adjustment is done with the JDemetra+ software.

2.3 Results and Conclusions

The raw mileage index for the period January 2020 and March 2024 is shown in Figure 1.

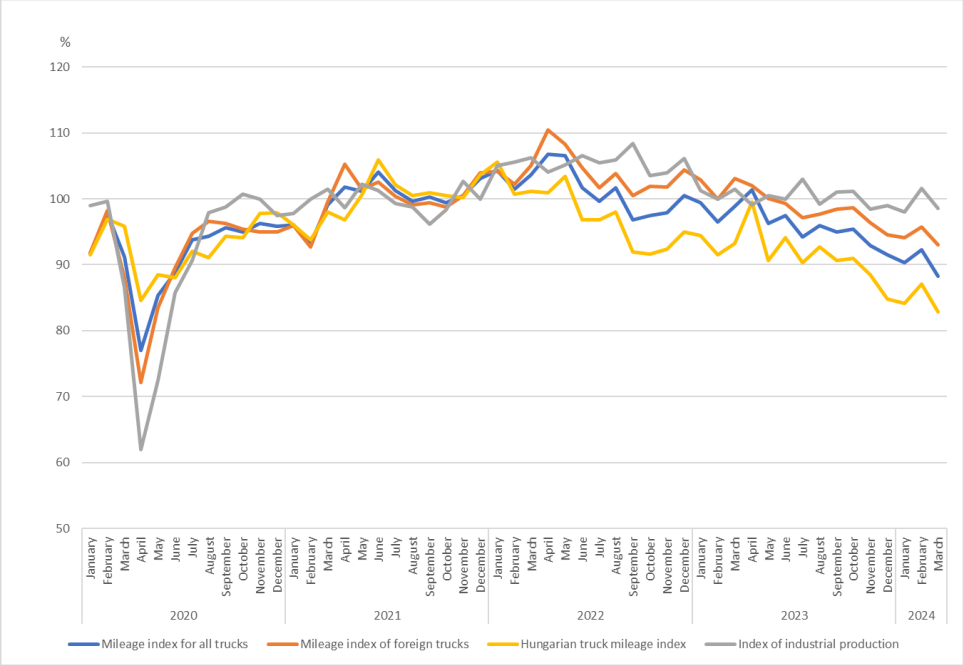
Figure 1: Mileage index of trucks subject to road tolls and the development of industrial production (Raw indices, 2021 average=100.0%)



It can be seen that, apart from some outlier months, industrial production and the mileage indexes (especially Mileage index for all trucks and that for foreign trucks) move closely together.

This close co-movement is also true for the seasonally adjusted data, which can be seen in Figure 2.

Figure 2: Mileage index of trucks subject to road tolls and the development of industrial production (Seasonally adjusted data, 2021 average=100.0%)



We measured the following correlations in the period we examined, which is summarized in the Table 1. It can be clearly seen that the Mileage index of foreign trucks and Mileage index for all trucks show a strong relationship with the industrial production index.

Table 1: Correlation between truck mileage indices and industrial production index

Truck mileage indices	Industrial production index
Hungarian truck mileage index	0.56
Mileage index of foreign trucks	0.80
Mileage index for all trucks	0.89

Based on this result, we argue that we succeeded in forming a business cycle indicator with high explanatory power. For now, the HCSO does not publish it, as it is in an experimental phase.

In the future, we would like to examine whether a suitable weekly time series can be produced from the available data. If NTPS Plc. would provide the data on a weekly basis in the future, we would be able to see the development of industrial production in near real time.

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